On the Relative Importance of Natural Versus Human-induced Climage Changes

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Publication Date:
Spring 91 - Volume 22 #2

Document ID: KARLS001

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Climate probably exerts a more profound influence on human history and nonhuman ecosystems than any other single environmental factor. Many scientists now warn us that the buildup of greenhouse gases (carbon dioxide (CO2) , chlorofluorocarbons (CFCs), nitrous oxide, methane and ozone) from industrial activities has begun to increase the atmosphere's natural greenhouse effect, causing a global warming. In particular, burning of fossil fuels (coal, oil, and natural gas) adds about 5.6 billion tons of carbon per year to the atmosphere and is thought to be responsible for most of the CO2 buildup, as well as being a major source of nitrous oxide, methane and ozone. Climatologists note that the increase of atmospheric CO2 from about 290 to 350 ppm between 1860 and the present coincides with a 0.6 C increase in average global temperature. And they predict that, barring a natural cooling trend, our continued burning of fossil fuels and destruction of forests could cause a doubling of atmospheric CO2 (to 700 ppm) in the next several decades. Computer models suggest this CO2 doubling could result in an increase of average global temperatures of 1.5 to 4.5 C and up to 10 to 15 C near the poles. Obviously, this amount of warming would alter temperature and precipitation patterns and produce higher sea levels (by 0.5 to 1.5 m), severely disrupting modern societies.

There are problems with this scenario, however. First, our understanding of the nearly infinitely complex climate system is still very incomplete. Thus, we can't be sure that the 0.6 C warming of the last century isn't attributable to natural climate perturbations, perhaps resulting from solar variability, tidal forces, changes in volcanic activity, migration of air pressure belts and ocean circulation systems, or some combination thereof. Indeed, historic evidence indicates that temperatures fluctuated by 0.60 C or more during several intervals in the past 2000 years. These include the Medieval warm period (8th to 11th centuries AD) and the "Little Ice Age" (16th to 19th Centuries AD). And natural climate changes during the past several million years have been far more dramatic than anything we have seen this century or have projected for the next, indicating that natural processes have had far greater effect on climate than human activities.

Paleoclimatologists reconstruct the earth's climatic history on the basis of "proxy" evidence, including distribution of fossils, pollen, glacial deposits and soils, lake and deep-sea core records, coastline features, tree-rings, etc. Collectively, this evidence suggests that the earth's average temperature for most of its history has been about 10 to 15 degrees C warmer than the present 15 C. However, approximately every 200 – 250 million years, the earth's heating system has "broken down," resulting in a relatively brief glacial episode. We are presently living in one of these glacial periods, termed the Quaternary, which began in earnest about 2 – 3 million years ago and has included about 10 glacial/interglacial cycles within the last approximately 1 million years. For the past approximately 10,000 years, we have been in a relatively warm "interglacial" stage called the Holocene.

We can get a sense of the magnitude of the earth's climatic variability by looking at climates of the past 65 million years. Near the end of the Mesozoic (=middle life, age of dinosaurs) and the beginning of the Cenozoic (=new life, the age of mammals) about 65 million years ago, world climate was much warmer and moister than present, land covered only about 15% of the earth) as opposed to 30% now), and sea level was about 500 m higher than present. Conditions were semi-tropical worldwide and eucalyptus trees thrived on Greenland. Climate cooled gradually during the Cenozoic and by 30 million years ago small glaciers had begun developing in Alaska and Antarctica. By about 2 million years ago, glaciers in the northern hemisphere began to reach continental proportions and Icelandic fauna began appearing in the Mediterranean. Since then, cold glacial conditions have alternated with relatively warm interglacials, with glacials and interglacials both becoming progressively towards the present. During the last interglacial, about 125,000 years ago, average temperatures were as much as 3 to 4 degrees C higher than today, average sea levels were about 5 m higher than present, and warmth-loving critters (including giant tortoises and alligators) migrated far north of their present habitats. During the last glaciation, the Wisconsinan, which culminated about 18,000 years ago, huge glaciers one to two miles thick covered Canada and the northern U.S. and northern Europe and Eurasia, while smaller glaciers capped the world's mountainous areas. Due to the tremendous buildup of ice on land, sea levels dropped by 100 m and there was 12% more land than today. The expansion of glaciers and land masses caused average

temperatures to plummet by 8 to 20 C over land and 3 to 6 C over sea. Climate belts shifted southward by 20 to 30 degrees latitude and plants and animals, too, migrated far south of their present range. The rapid warming which caused deglaciation between about 15, 000 and 10,000 years ago was accompanied by catastrophic flooding, rapid rise of sea levels and massive extinctions of large mammals.

My own research on (subtropical-type) soils and periglacial deposits in Montana and Alberta suggests that average temperatures during interglacials about 2 million years ago were at least 6 to 8 C (and probably 10 or more) warmer than present, whereas average temperatures during the last glaciation were at least 10c C colder than today. Hence, average temperatures in this midcontinental region seem to have fluctuated by at least 16 to 18 C over the past 2 million years. A similar and even greater magnitude of climate change is recorded by fossil plant and animal remains and periglacial features in Eurasia.

What causes climate to change? The most favored theory today holds that glacial periods are initiated by uplift and poleward movement of the continents whereas glacial/interglacial fluctuations within glacial periods result from variations in the earth's orbit around the sun. These calculated astronomic periodicities (100,000, 40,000, and 20,000 years) coincide with dated climate cycles identified in deep-sea sediments and loess-soil sequences in Europe and China. In general, the 40,000 year obliquity cycle seems to predominate at high latitudes, the 20,000 precession cycle predominates at low latitudes and the 100,000 eccentricity cycle coincides with the length of a full glacial/interglacial cycle. Some scientists also detect higher frequency cycles which may correlate with (lunar) tidal force cycles, which peak every 1700 years and have 1100, 550 and 275 years subcycles. In addition, the well-known 11 year sunspot cycle, first identified in tree-ring records in the American southwest, has recently been shown to correlate with winter temperature fluctuations in the northern hemisphere. Recent research also suggests that the "solar constant" is not constant after all, but rather can vary by up to 0.2% within weeks. A 0.1% change can trigger up to 6 C temperature changes in polar regions. These findings suggest that solar variability might eventually prove to be a fundamental cause of climate change.

Hence, I suggest that many global warming experts today dramatically overestimate the effects of human activity on climate and that most or possibly all twentieth-century climate variability could be the result of natural climate fluctuations. Nonetheless, the global warming debate itself is still highly efficacious because it forces us to recognize that the earth environment – including human, nonhuman and inorganic members – is one interconnected system. We are now becoming increasingly aware of the many and myriad ways in which our human economy profoundly and adversely affects the environment. God's economy. Hence, we can now begin to envision the development of a "sustainable society" which operates within the limitations of our "allowance" of renewable resources – solar, wind, geothermal, etc., -- rather than on the wasteful consumption of nonrenewable resources such as fossil fuels. This would have many other advantages as well, including a reduced risk of world war in the Middle East.